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EFFECTS OF WASTE DISCHARGES ON WATER QUALITY OF THE CACHE LA POUDRE AND SOUTH PLATTE RIVERS, GREELEY AREA

National Field Investigations Center
Denver, Colorado

June 1972

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EFFECTS OF WASTE DISCHARGES ON WATER QUALITY OF THE CACHE LA POUDRE AND SOUTH PLATTE RIVERS GREELEY, COLORADO

National Field Investigations Center - Denver
and
Region VIII
Denver, Colorado

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GLOSSARY OF TERMS

BOD - Biochemical Oxygen Demand, 5-Day

COD - Chemical Oxygen Demand

DO - Dissolved Oxygen

NH_3-N - Ammonia Nitrogen

TOC - Total Organic Carbon

SS - Suspended Solids

RM - river mileage

cfs - flow rate given in cubic feet per second

gpm - flow rate given in gallons per minute

mgd - flow rate given in million gallons per day

mg/l - concentration given in milligrams per liter

µmhos/cm - unit of specific conductance (mho -- the inverse of the standard unit of electrical resistance, the ohm) measured over a 1-centimeter distance, conventionally made at 25°C.

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I. INTRODUCTION

The Great Western Sugar Company (subsidiary of the Great Western United Corporation) operates a sugar beet processing mill at Greeley, Colorado, on the Cache la Poudre River just upstream of its confluence with the South Platte River. Inadequately treated industrial wastes from this mill are discharged to the Cache la Poudre River. In addition to these discharges, a large volume of inadequately treated municipal wastes is discharged immediately upstream of the Great Western mill.

Stream surveys were conducted by the National Field Investigations Center - Denver (EPA) during the months of September and December 1971, to define conditions in the receiving waters prior to and during the sugar beet processing season (campaign) [Figure 1, inside back cover]. Waste treatment practices were evaluated at both the Great Western mill and the Greeley wastewater treatment plant. The latter was also evaluated in January 1972.

This report summarizes the results of these investigations. Observed water quality conditions are compared to the applicable water quality regulations, and violations of water quality standards are defined. Water quality conditions also are compared with conditions existing during studies conducted by the South Platte River Basin Project in 1963-66. The recommendations include remedial measures that are necessary to abate existing pollution.

II. SUMMARY AND CONCLUSIONS

There has been some reduction in the waste loads discharged to the Cache la Poudre River when compared with the findings of the South Platte River Basin Project studies in 1964-65. This has resulted from the closure of the Great Western mill at Windsor and improved treatment at the Great Western mill in Eaton which discharges to Eaton Draw. However, water quality investigations conducted during September and December, 1971, showed that the receiving waters were still being severely degraded by waste discharges from the Greeley wastewater treatment plant and the Great Western mill at Greeley, Colorado. Violations of Sections B and D of the Basic Water Quality Standards are occurring.

The December 13 through 15, (1971) survey findings indicated that the Great Western mill was discharging a BOD load of about 25,000 lb per day to the Cache la Poudre River (10.7 lb of BOD per ton of sliced beets). This greatly exceeds the effluent limits (i.e., 0.5 lb of BOD per ton) attainable by recommended treatment practices for the sugar beet industry. At this effluent limit, the Great Western mill discharge would contain a BOD load of no more than 1,165 lb per day based on 1971-72 campaign figures.

The degree of treatment provided by the serpentine shaped ditch is negligible--about 10 percent, which is no better than that observed during the 1963-64 campaign. Effluent from the ditch is black and septic. The fecal coliform density (log mean) was 210,000/100 ml during the survey. Waste abatement requirements of the State of Colorado are not being met

at the Great Western mill in Greeley. Moreover, neither the compliance date established in the State implementation plan (December 31, 1970), nor the date recommended by the Conferees (June 30, 1971) at the reconvened second session of the South Platte Conference has been met.

Compounding the pollution problems in the Cache la Poudre River is the Greeley waste treatment plant that is grossly overloaded organically and discharges from 10,000 to 22,000 lb BOD per day. Wastes from the Monfort of Colorado packing plant of approximately 16,000 lb BOD per day exceed the design capacity. A new facility to treat the Monfort wastes and the waste activated sludge from the existing plant will be constructed about five miles east of Greeley. This facility is to produce an effluent containing no more than 20 mg/l and will reduce the present BOD load to the existing plant by greater than 50 percent. With this reduction it should be possible for the effluent limits of 25 mg/l BOD and suspended solids to be met.

An examination of the flow records (1951-70) for the Cache la Poudre River at RM 2.9 shows that the 7-day, 10-year low flow is 6 cfs. In 16 of 20 years, the 7-day low flow occurred in either May, June or July. Upstream at RM 4.6 flow is diverted for irrigation generally from May through mid-October. The diversion flow records for the same 7-day periods were used to estimate flow conditions in the Cache la Poudre River just downstream from the Greeley wastewater treatment plant. On this basis, the 7-day, 10-year flow was about 39 cfs. Further examination of the records during the period October to February shows that the 7-day, 10-year

low flow at RM 2.9 is 12 cfs. Seventeen of the 7-day, low-flow periods occurred in October. Allowing for the diversions, the 7-day, 10-year low flow just downstream from the Greeley wastewater treatment plant was also about 30 cfs. Unless treatment at the Greeley plant is upgraded to produce an effluent containing not more than 25 mg/l BOD (maximum 1700 lb at design flow of 8 mgd), the present DO standards of 3.0 mg/l cannot be met under these flow conditions.

Water quality conditions observed upstream of the Greeley and Great Western discharges were indicative of a moderately polluted stream resulting from irrigation drainage, possible residual wastes from upstream discharges, and agricultural activities along the river. Violations of the bacterial standards for a warm-water fishery were indicated at 6th Avenue during the September 1971 survey. A flow of no less than 15 cfs in the Cache la Poudre from upstream of the Greeley wastewater treatment plant downstream to the point of the Great Western discharge is considered necessary to maintain a minimum dissolved oxygen level of 3.0 mg/l.

III. RECOMMENDATIONS

In order to achieve abatement of pollution of the Cache la Poudre and South Platte Rivers resulting from the discharges of inadequately treated wastes, it is recommended that:

1. The combined waste discharges from the Great Western mill at Greeley contain not greater than 0.5 lb each of BOD and suspended solids per ton of beets sliced or the total load of each not exceed 1,165 lb per day (based on 1971-72 campaign figures), whichever is less.

2. The number of fecal coliform organisms in the combined discharges not exceed 75×10^6 organisms per ton of beets sliced or density of 1,000/100 ml, whichever is less.

3. The effluent from the existing wastewater treatment plant at Greeley contain not greater than 25 mg/l each of BOD and suspended solids with the maximum BOD and suspended solids load not to exceed 1700 lb per day each at design flow.

4. The City of Greeley proceed with the proposed construction of a new plant to treat the Monfort Packing plant wastes and the waste activated sludge from the existing plant with the effluent from the new system to contain not greater than 25 mg/l each of BOD and suspended solids.

5. The Greeley wastewater treatment effluents be disinfected in accordance with applicable criteria.

6. Stream flows not less than 15 cfs be maintained in the Cache la Poudre upstream from the Greeley wastewater treatment plant. Flow past the irrigation diversion at RM 4.6 shall also be 15 cfs which will require limitations of diversion during drought periods.

IV. APPLICABLE WATER QUALITY REQUIREMENTS

A. WATER QUALITY STANDARDS

Water quality standards applicable to the South Platte River and its tributaries in Colorado were established in June 1967 by the Colorado Water Pollution Control Commission.[1/] These standards were subsequently revised and fully approved as Federal standards. They consist of three components: 1) stream classifications that designate water uses to be protected; 2) water quality criteria that specify water quality conditions which must be maintained; and 3) an implementation plan that establishes time schedules for providing adequate treatment or control facilities for all sources of pollution.

The South Platte River from the Denver area (RM 313.4) downstream to the Nebraska state line is classified for industrial and agricultural water uses (Class C and D_1). From near Fort Collins (RM 55.0) downstream to Second Avenue in Greeley (RM 5.5) the Cache la Poudre River is classified as a warm water fishery, and for industrial and irrigational uses (Classes B_2, C, and D_1). Downstream to the mouth, the classification is C and D_1 [water quality criteria applicable to the above classifications can be found in Appendix A]. An implementation schedule was established that required the Great Western mill at Greeley to be in compliance with the water quality standards by December 31, 1970.

B. ENFORCEMENT CONFERENCE REQUIREMENTS

First Session

In 1963, the First Session of the *Conference in the Matter of Pollution of the South Platte River Basin in the State of Colorado* was called under provisions of the Federal Water Pollution Control Act by the U. S. Department of Health, Education, and Welfare at the request of the Colorado Governor, John Love. To comply with the recommendations of the First Session, the South Platte River Basin Project of the Department of Health, Education, and Welfare was established. The Project was requested to undertake a study to determine legitimate water uses and locate the sources of pollution having an adverse effect on those uses; determine through field investigations the physical, chemical, and biological responses of the South Platte River to pollution and evaluate the sources of pollution with respect to the conditions in the River; and to compute the waste load reductions necessary to obtain desired water quality and recommend the water quality control measures needed to effect the desired waste load reductions.

Second Session

The Second Session of the Conference, held in April 1966, was primarily devoted to the presentation of the results of the studies. Water quality objectives for the South Platte and Cache la Poudre Rivers and waste treatment requirements for the Great Western sugar mill at Greeley were included [Appendix B]. These recommendations called for waste discharges from the Greeley mill to be reduced to 1,100 lb per day each of BOD and suspended solids.

The Conference adjourned without formulating specific pollution abatement recommendations in order to allow the new Colorado Water Pollution Control Commission sufficient time to study and evaluate the report of the Project and to develop a program and time schedule for implementation of remedial measures.

Reconvened Second Session

In November 1966 the Conferees recommended that the final compliance date for providing adequate treatment of all waste discharges in the Basin be extended from the recommended date of September 30, 1968, to June 30, 1971.

> "All discharges into the South Platte River Basin shall have adequate remedial or control facilities in full operation by June 30, 1971, so as to comply with water quality standards established by the Colorado Water Pollution Control Commission as approved by the Secretary of the Interior."[2/]

The Conferees did not adopt the water quality objectives or waste treatment requirements recommended by the Project although a number of these recommendations were subsequently incorporated in the Colorado Water Quality Standards.

V. WASTE SOURCES

Municipal and industrial waste source investigations were conducted in the Greeley area during September and December 1971 and in January 1972. Data on water pollution control practices were obtained through in-plant surveys, review of the Refuse Act permit applications, and through contact with both Company representatives and wastewater treatment plant operators.

A. GREELEY WASTEWATER TREATMENT PLANT

This treatment system consists of conventional activated sludge with primary clarification, separate sludge digestion, and chlorination. The system is designed for 8.0 mgd and an organic loading of 13,000 lb of BOD per day. In addition to serving a population of more than 53,000 persons, the facility treats the waste from the Monfort of Colorado packing plant. The Greeley treatment plant discharges directly to the Cache la Poudre River (RM 5.3). Previous studies, by the Project in 1966, showed that this treatment plant was providing greater than 90 percent BOD removal. The Monfort plant was not connected to the Greeley treatment plant at that time.

The more recent in-plant surveys, conducted by NFIC-Denver,* indicate that the plant is grossly overloaded organically. The Monfort plant contributed flows of 1.6 to 1.8 mgd, with an average BOD of approximately 1,200 mg/l. This constitutes a BOD load of about 16,000 lb/day, which

* Composite samples (24-hour) were collected of the influent and effluent [Figure 1-Station E].

is in excess of the wastewater treatment plant design capacity. The influent BOD to the Greeley plant (combined Monfort and domestic wastes) is generally in excess of 500 mg/l, with flows averaging about 7.0 mgd. The BOD removal efficiency varies from 25 to 60 percent. The BOD loads discharged ranged from approximately 10,000 to 22,000 lb per day.

In addition to the activated sludge plant, there is a trickling filter plant (two filters in parallel) that became inoperative after the activated sludge plant was constructed. Attempts are being made to use the trickling filter plant for treatment of the Monfort wastes ahead of the activated sludge system. However, even with the treatment provided by the filters, the total load placed on the activated sludge system will still be above the design capacity.

Disinfection at the Greeley plant is inadequate. Little or no chlorine residual was detected in the effluent during the in-plant surveys. For example, during the January 1972 survey, the log mean total- and fecal-coliform bacteria densities were 12,000,000 and 1,300,000/100 ml, respectively. Applicable criteria,[3/] which require that 1 mg/l chlorine residual be maintained after 15 minutes detention time at peak hourly flow, were not being met.

To alleviate the overloaded condition the City of Greeley, with the assistance of an EPA grant, will construct a new treatment facility that will be located about five miles east of Greeley and one mile north of Colorado Highway 263. This plant (2.8 mgd design capacity) will consist of four anaerobic lagoons in parallel, followed by two aerated lagoons, clarification, and two polishing ponds in series and will treat Monfort wastes and the waste activated sludge from the existing plant.

B. GREAT WESTERN SUGAR MILL

This mill is a straight-house operation processing an average of 2,330 tons of beets per day. Water is obtained from the Cache la Poudre River (approximately 5 mgd), City of Greeley (approximately 0.7 mgd), and from wells. A city storm sewer also discharges to the mill water supply pond. If necessary, barometric condenser waters can be released to the pond.

The Greeley mill has three known discharges: 1) the effluent (001)* from the long, serpentine shaped ditch at RM 4.3 [Figure 1-Station A]; 2) the effluent (002) containing boiler blowdown and the ashes and unburned coal and coke residues originating from the boilers and lime kiln at RM 5.25 [Figure 1-Station C]; and 3) the occasional overflow from the water supply pond (003) at approximately RM 5.27 [not shown on Figure 1].

The lime muds that constitute another source of waste are pumped to an 8-to-10-acre holding basin located on the east side of the Cache la Poudre River. According to Company officials, there is no discharge from the holding pond.

The influent to this serpentine shaped ditch is composed of waste flume waters, excess condensates, leaks, spills, boilouts, and other miscellaneous wastes. The ditch is approximately 1.25 miles in length and is reported to vary from 14 to 20 ft in width and from 3 to 7 ft in water depth. Results of an in-plant survey [Table 1] during December 13 to 15, 1971, showed that the ditch provided about 15 percent BOD removal.

* Numbers refer to Refuse Act Permit designations of the Great Western Sugar Company.

TABLE 1
SUMMARY OF FIELD MEASUREMENTS AND CHEMICAL AND BACTERIOLOGICAL ANALYSES
GREAT WESTERN SUGAR MILL, GREELEY, COLORADO
December 12-15, 1971

Map Key[a]	Station Description	FIELD MEASUREMENTS AND ANALYTICAL RESULTS							BACTERIOLOGICAL RESULTS					
		Flow (mgd)		pH	Temp. (°C)	Cond. (µmhos/cm)	BOD (mg/l)	TOC (mg/l)	Fecal Coliform (MF Count/100 ml)			Fecal Streptococci (MF Count/100 ml)		
		Range	avg	Range	Range	Range	avg	avg	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
B	Influent to serpentine ditch			8.6-8.8	25-30	1,200-1,350	726	590						
A	Effluent from serpentine ditch (RM 4.3)	5.1-4.6	4.9	6.7-7.4	20-24	1,500-1,800	615	580	780,000	210,000	130,000	11,000,000	> 3,500,000	> 1,000,000
C	Effluent from ash disposal and boiler blowdown system (RM 5.25)		0.08[b]	8.1-10.2	5-46	1,650-2,150	1,230	1,190	650,000	> 150,000	> 60,000	12,000,000	> 3,100,000	> 100,000
D	Water supply intake from pond			7.7-7.9	0-1	1,400-1,450	9	5						

a/ See Figure 1.
b/ Company data for months of October-December 1971.

The effluent (002) from the boiler and lime kiln area had an extremely high BOD (1,230 mg/l) compared to the data submitted by the Company [Table 2]. Wastewaters other than those from the boilers and lime kiln area were apparently entering the discharge line. The Company data indicate that the mill was discharging an average of 9.4 lb BOD per ton of beets processed. The December survey results show that 10.7 lb BOD per ton of beets were discharged.

An aerial reconnaissance was conducted of the Cache la Poudre River on December 16, 1971, downstream from its confluence with the South Platte River to upstream of the Monfort of Colorado feedlots. At the point of discharge from the ditch [Figure 2] the black effluent, which has greater density than the receiving waters, flows below the stream surface for a short distance downstream and subsequently mixes. After the effluent was dispersed, the Cache la Poudre River appeared black downstream to the confluence with the South Platte River [Figure 3]. The inflow clinging to the bank finally began to disperse about 150 yards downstream.

Wastewater treatment has not improved since January 1964[4/] when studies by the South Platte River Basin Project indicated BOD removals of about 10 percent. The net load* from the mill approximated 13 lb BOD per ton of beets processed at that time. Treatment at this mill should be in accord with base-level treatment practices for the sugar beet industry, i.e., 0.5 lb of BOD per ton of beets processed.

* The BOD load in the river water supply was subtracted from the final effluent BOD. The mill processed an average of 2,200 tons of beets during the 1963-64 campaign.

Photographs taken during the course of this investigation are on file in the Denver, Colorado, office of the National Field Investigations Center.

Figure 2

Aerial view of Great Western waste effluent (serpentine ditch) at point of discharge to the Cache la Poudre River. (Arrows indicate direction of flow.)

Photographs taken during the course of this investigation are on file in the Denver, Colorado, office of the National Field Investigations Center.

Figure 3

Aerial view of the confluence of the South Platte and Cache la Poudre Rivers. (Arrows indicate direction of flow.)

C. FARR FARMS FEEDLOT OF GREELEY

Approximately 15,000 head of cattle are fed at Farr Farms. In 1964-66 the feedlots were drained by underground pipes and this drainage along with surface runoff was discharged directly to the Cache la Poudre River. It was recommended at the Second Session of the Conference that feedlot owners design and construct berms or suitable drainage facilities to divert the surface runoff to lined lagoons or treat these wastes by equivalent means in order to protect against pollution of both surface and ground water.

Present treatment facilities consist of holding ponds with the effluent either used for irrigation or diverted to evaporation lagoons. During the surveys, conducted in September and December 1971, there was no apparent contamination from these feedlots.

D. MONFORT OF COLORADO

This company operates feedlots and a packing plant. Feedlots have a total capacity for feeding 112,000 head of cattle and are located north of Greeley and at Evans, Colorado. Water pollution control recommendations presented at the April 1966 session of the Conference were the same as those for the Farr Farm feedlots. The waste treatment facilities for the Monfort feedlots consist of holding ponds with the effluent used for irrigation of crops. At the packing plant, cooling water and the defrost water are discharged directly to the Cache la Poudre River. As stated previously, the packing house wastes are sent to the Greeley wastewater treatment plant.

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VI. STREAM SURVEYS

A. SOUTH PLATTE RIVER BASIN PROJECT STUDIES

Studies, conducted during September 7 to 12, 1965,[5/] showed that the Cache la Poudre River became degraded as it coursed through Greeley. The BOD at Spanish Colony (RM 9.4) was 3.5 mg/l and increased to approximately 5.0 mg/l at a station just upstream (RM 5.7) of the Greeley wastewater treatment plant. Eaton Draw (RM 6.9) contained 10.9 mg/l BOD at a flow of 1.3 cfs. Downstream (RM 5.2) from the Greeley plant the BOD increased to 28.0 mg/l. Near the mouth (RM 2.9) the BOD had decreased to 7.1 mg/l. Flows during 1965 were as follows:

RM 9.5 - Spanish Colony	23 cfs
RM 5.7 - Upstream of Greeley Wastewater Treatment Plant	55 cfs
RM 5.2 - Downstream from Greeley Wastewater Treatment Plant	75 cfs
RM 2.9 - Near mouth	40 cfs

Flow variations were due to irrigation return drains, seepage, and waste discharges. Downstream from RM 5.2, a portion of the flow was diverted for irrigation.

Water quality of the Cache la Poudre River, during the 1965 survey, was generally good in the upper reach, i.e., upstream of RM 46.0, with total- and fecal-coliform bacteria densities averaging 250 and 74 MPN/100 ml, respectively. Downstream from RM 46.0, the water quality deteriorated. The levels of total and fecal coliform bacteria (2,100,000 and 400,000 MPN/100 ml, respectively) downstream from the Greeley plant were two orders of magnitude greater than those at the station just upstream, thus

confirming that disinfection practices at the plant were ineffective.

The effects of the Great Western mill discharges at Greeley were measured during the 1963-64 sugar beet campaign. The quality of the Cache la Poudre River water in the Greeley area was degraded by residual wastes from the Great Western mills at Windsor and Eaton, and the Monfort packing plant. Through Greeley, the BOD increased from approximately 200 mg/l to 350 mg/l (RM 9.4 and RM 2.9, respectively). The effluent from the Great Western mill in Greeley contained 27 mg/l sulfides. During January 1964, it was reported,[6/] the lower portion of the Cache la Poudre River represented the most severe case of surface water pollution existing in the entire South Platte River Basin. Since the 1964-66 survey, the Great Western plant at Windsor has closed; the Great Western mill at Eaton has constructed pollution control facilities; and the Monfort plant presently diverts all wastes to the Greeley sewage treatment plant. The major waste discharges remaining are those from the Greeley wastewater treatment plant and the Great Western mill at Greeley.

B. WATER QUALITY SURVEY, SEPTEMBER 13-15, 1971

During the survey, more than 50 miles (RM 53.6 to the mouth) of the Cache la Poudre River were studied. Of primary interest is the reach extending from Spanish Colony (RM 9.4) downstream to the confluence with the South Platte River. As mentioned earlier, the Cache la Poudre River has been classified as B_2, C, and D_1 waters from RM 55.0 to RM 5.5, and C and D_1 downstream to the mouth.

The DO concentration at Spanish Colony neared or exceeded saturation

level [Table 3]. The log mean fecal coliform density of 640/100 ml [Table 4] was within the standard (1,000/100 ml) established for a warm-water fishery.

The river at 6th Avenue (RM 6.3) showed the effects of several irrigation drains including Eaton Draw. Dissolved oxygen concentrations were generally below saturation levels but well above the DO standard of 5.0 mg/l. At this station the log mean fecal coliform density (3,200/100 ml) was a violation of the standards.

Effects of the Greeley wastewater treatment plant (RM 5.3) were evident at RM 5.2 and 0.5. At these stations the DO concentrations were below saturation levels (32 to 84 percent) all the time with the dissolved oxygen standard of 3.0 mg/l being violated at RM 0.5. Densities of fecal coliform bacteria at these stations exceeded 2,000/100 ml (log mean) but were less than the levels observed at 6th Avenue. This is contradictory to what would be expected because adequate disinfection was seldom accomplished during the in-plant evaluations of the Greeley wastewater treatment plant. As previously discussed, during the January 1972 in-plant survey, the fecal-coliform bacteria levels in the effluent exceeded 1,000,000/100 ml.

The Cache la Poudre River was virtually an open sewer downstream from the Greeley discharge. The murky water smelled of sewage, and rich organic sludge beds blanketed most of the stream bottom. Such sludge beds constitute a violation of Sections B and D of the Basic Water Quality Standards [Appendix A]. Sludgeworms were profuse in number (22,810/ft^2)

TABLE 3
SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS AT SELECTED STATIONS
CACHE LA POUDRE AND SOUTH PLATTE RIVERS
September 13-16, 1971

Map No.	Station Description	Flow cfs avg	pH S.U. Range	Cond. µmhos/cm Range	Temp. °C Range	Dissolved Oxygen mg/l Range	Dissolved Oxygen Percent Sat. Range	Total Alkal. mg/l avg	BOD mg/l avg	Total Solids mg/l avg	Susp. Solids mg/l avg	TOC mg/l avg	Turbid. J.T.U. avg
1	South Platte River at Kersey, Colorado (RM 246.5)	440	8.1-8.2	1600-1850	11-15	7.2-8.2	71-78	243	4.1	1285	48	48	17
2	Cache la Poudre just upstream of mouth at Davis Ranch (RM 249.0/0.5)	90	7.7-7.8	1900-2000	11-15	2.7-6.1	32-68	254	10.1	1440	35	8	12
3	South Platte River one mile upstream of mouth of Cache la Poudre River (RM 250.6)	350[a/]	8.1-8.2	1800-2000	11-15	6.9-8.5	75-81	238	1.8	1255	45	-	16
4	Cache la Poudre River downstream from Greeley wastewater treatment facility (RM 249.0/5.2)	75[a/]	7.7-8.1	1900-2600	12-14	3.9-6.8	43-84	251	27	1473	78	-	31
5	Cache la Poudre River at 6th Avenue in Greeley (RM 249.0/6.3)	50[a/]	7.9-8.2	2000-2500	11-14	6.9-8.5	75-100	257	3.4	1355	50	-	20
6	Eaton Draw near mouth (RM 249.0/6.9/0.1)	1.5	8.5[b/]	1650-1900	11-14	7.6-9.3	85-101	201	10.5	1367	100	10	42
8	Cache la Poudre River at Spanish Colony at 23rd Avenue Bridge (RM 249.0/9.4)	40	7.6-8.1	1750-2100	11-14	8.7-13.9	96-155	275	1.9	1785	< 10	3	5
9	Irrigation return just downstream from 23rd Avenue Bridge (RM 249.0/9.35/0.1)	7.5	7.9-8.1	1350-2600	10-12	8.6-9.4	96-103	206	7.0	1825	310	-	121

a/ Estimated values.
b/ All pH values were the same for this station.

TABLE 4

RESULTS OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS
CACHE LA POUDRE AND SOUTH PLATTE RIVERS
September 13-15, 1971

Map No.	Station Description	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
1	South Platte River at Colorado 37 Bridge north of Kersey at USGS gage. (RM 246.5)	90,000	33,000	13,000	8,200	2,000	840	11,000	2,700	880
2	Cache la Poudre River just upstream of mouth, at Davis Ranch. (RM 249.0/0.5)	5,200	27,000	1,200	3,300	2,100	1,400	7,200	2,600	1,000
3	South Platte River at highway bridge 1 mile upstream of mouth of Cache la Poudre River. (RM 250.6)	25,000	18,000	15,000	900	450	220	3,400	2,400	1,300
4	Cache la Poudre River downstream from Greeley wastewater treatment plant at highway bridge. (RM 249.0/5.2)	> 80,000	> 38,000	9,000	5,400	2,500	780	32,000	20,000	12,000
5	Cache la Poudre River at 6th Ave. bridge in Greeley. (RM 249.0/6.3)	37,000	20,000	9,000	7,300	3,200	650	57,000	16,000	1,500
8	Cache la Poudre River at 23rd Ave. bridge in Greeley. (RM 249.0)	11,000	9,600	8,000	890	640	520	3,400	1,100	440

because of the available food and the lack of competition in their sludge bed habitat. Fish populations near the mouth of the Cache la Poudre consisted of forage species; no game fish were found.

Water quality conditions were measured in the South Platte River upstream and downstream from the confluence of the Cache la Poudre River. Upstream, the biological quality of the river was moderately degraded. Because the sand substrate was poor habitat, only six kinds of benthic invertebrates with a density of 74/ft^2 inhabitated this reach. Of these, approximately equal portions were tolerant and sensitive forms. Fish populations in this reach consisted entirely of non-game species, such as longnose suckers, minnows, and carp.

At Kersey, the South Platte River became severely polluted as a result of the Cache la Poudre inflow. The numbers of coliform bacteria in the water were excessive; total coliforms numbered 33,000/100 ml and fecal coliforms numbered 2,000/100 ml. Because of a shifting sand substrate the density of organisms was only 62/ft^2. Pollution-tolerant sludgeworms increased to 37 percent of the population and intolerant forms decreased to 3 percent.

In summary, the water quality conditions observed in the study reach were similar to those observed during the summary of 1965.

C. WATER QUALITY SURVEY, DECEMBER 6, 7 AND 13 TO 15, 1971

The Cache la Poudre River was studied from RM 7.0 (upstream of Eaton Draw) downstream to its confluence with the South Platte River in order to determine the combined effects on water quality of the discharges from the Great Western mill and the Greeley wastewater treatment plant. Water

quality data were collected on the South Platte River upstream and downstream from the mouth of the Cache la Poudre River and at the mouth of Eaton Draw. Also determined were the waste loads discharged by the Greeley wastewater treatment plant and the Great Western sugar-beet processing mill.

Upstream of Eaton Draw, the Cache la Poudre River was moderately degraded [Tables 5 and 6] because of residual wastes from upstream discharges, irrigation drainage, and agricultural activities. Nutrients were available in sufficient quantities to stimulate algal growths (3.8 million cells/in^2). The bacteriological studies showed log mean total and fecal coliform bacteria concentrations of 1,800 and 150/100 ml, respectively. Organic enrichment also affected the benthos community. Sludgeworms and facultative or pollution-tolerant fly larvae accounted for 95 percent of the bottom animals collected. Dissolved oxygen concentrations and coliform levels were well within the established standards.

The quality of the Cache la Poudre River at 6th Avenue was similar to that observed upstream of Eaton Draw. Changes in the benthos community were limited primarily to a reduction in numbers because of better substrate (more sand and less sludge). The BOD levels had increased slightly (5.0 mg/l to 8.5 mg/l), attributable to inflows from Eaton Draw. The DO concentrations and fecal-coliform bacteria levels met the standards.

Downstream from the Greeley wastewater treatment plant, the Cache la Poudre River was severely polluted. The average BOD was 33 mg/l (range 22 to 48 mg/l). The Greeley plant (RM 5.3) was discharging more than 10,000 lb of BOD per day during the survey. Fecal-coliform bacteria densities (log mean) were 3,400/100 ml, or 15 times greater than the level observed at the 6th Avenue station.

TABLE 5
SUMMARY OF FIELD MEASUREMENTS AND ANALYTICAL RESULTS AT SELECTED STATIONS
CACHE LA POUDRE AND SOUTH PLATTE RIVERS
December 6-7, 13-15, 1971

Map No.	Station Description	Flow cfs avg	pH Range	Cond. µmhos/cm Range	Temp. °C Range	Dissolved Oxygen mg/l Range	Dissolved Oxygen % Sat. Range	Tot. Alkal. mg/l Avg.	BOD mg/l avg	TOC mg/l avg
1	South Platte River at Kersey, Colorado (RM 246.5)	842	7.5-7.8	1300-1500	0-2.5	7.7-9.1	64-79	254	21	94
2	Cache la Poudre River near mouth at Davis Ranch (RM 249.0/0.5)	166	7.4-7.8	1400-1700	0.5-5.0	5.1-7.1	48-63	271	59	131
3	South Platte River one mile upstream of mouth of Cache la Poudre River (RM 250.6)	670 (est)	7.4-7.8	1300-1500	0-2	8.9-10.0	74-86	244	12	89
4	Cache la Poudre River downstream from Greeley wastewater treatment facility (RM 249.0/5.2)	132 (est)	7.6-7.9	1050-1700	0.3.5	8.2-9.6	72-81	--	33	104
5	Cache la Poudre River at 6th Avenue in Greeley (RM 249.0/6.3)	122 (est)	7.8-8.1	1000-1800	0.0-2.5	10.6-12.1	89-108	253	8.5	83
6	Eaton Draw at mouth[a/] (RM 249.0/6.9/0.1)	11[b/]	7.8-8.3	1500-1850	4-8	9.1-10.0	94-109	335	14	10
7	Cache la Poudre River upstream of Eaton Draw (RM 249.0/7.0)	115	7.5-8.0	1300-1725	0-2.5	10.6-12.7	89-96	247	5	82

a/ This station sampled during the period November 30-December 4, 1971.
b/ Flows recorded during the period December 6,7, and 13-15. The average flows recorded at the time of sampling was 22 cfs.

TABLE 6
RESULTS OF BACTERIOLOGICAL ANALYSES AT SELECTED STATIONS
CACHE LA POUDRE AND SOUTH PLATTE RIVERS
December 6, 7, and 13-15, 1971

Map No.	Station Description	Total Coliform MF Count/100 ml			Fecal Coliform MF Count/100 ml			Fecal Streptococci MF Count/100 ml		
		Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum	Maximum	Log Mean	Minimum
1	South Platte River at Colorado 37 Bridge north of Kersey at USGS gage (RM 246.5)	1,000,000	> 160,000	59,000	72,000	15,000	4,400	520,000	95,000	12,000
2	Cache la Poudre River just upstream of mouth, at Davis Ranch (RM 249.0/0.5)	1,500,000	> 180,000	50,000	1,000,000	19,000	4,800	1,400,000	420,000	260,000
3	South Platte River at highway bridge 1 mile upstream from mouth of Cache la Poudre River (RM 250.6)	960,000	140,000	48,000	36,000	4,300	890	33,000	11,000	4,800
4	Cache la Poudre River downstream from Greeley wastewater treatment plant at highway bridge (RM 249.0/5.2)	1,400,000	47,000	4,900	150,000	3,400	200	1,500,000	19,000	2,600
5	Cache la Poudre River at 6th Ave. bridge in Greeley (RM 249.0/6.3)	3,700	1,900	660	650	220	120	3,900	1,900	1,100
6	Eaton Draw at mouth (RM 249.0/6.9/0.1)				720	500	360	18,000	6,800	2,900
7	Cache la Poudre River upstream of the mouth of Eaton Draw (RM 249.0/7.0)	3,800	1,800	1,100	690	150	50	2,600	1,500	600

Severe pollution conditions continued to exist near the mouth as a result of the discharge from the Great Western mill (total BOD load from the Greeley plant and Great Western mill was about 35,000 lb per day. The density (log mean) of fecal coliforms had increased to 19,000/100 ml. The river was murky and covered with slimes, primarily *Sphaerotilus*. The BOD ranged from 30-135 mg/l. The DO concentrations varied from 48 to 63 percent of saturation, but were above the applicable criterion (3.0 mg/l).

Comparison of water quality conditions upstream and downstream from the Cache la Poudre River confluence showed that the Cache la Poudre inflow degraded the South Platte River. Bacterial contamination from fecal coliforms increased nearly four times. Dense growths of *Sphaerotilus* developed. Sludgeworms increased in numbers and replaced pollution-sensitive insects in the South Platte River downstream from the Cache la Poudre River confluence.

In summary, the Cache la Poudre River upstream of Eaton Draw was moderately degraded due to sidual wastes from upstream discharges, irrigation drainage, and agricultural activities. The degraded condition was sustained at RM 6.3 by the inflow from Eaton Draw. Downstream from the Greeley wastewater treatment plant, the Cache la Poudre River was severely polluted. At RM 0.5, this condition was sustained because of the waste discharges from the Great Western mill. The effects of this pollution were evident in the South Platte River.

VII. WATER QUALITY IMPROVEMENT MEASURES

Low-flow conditions were examined for the Cache la Poudre River at the gaging station (RM 2.9) east of Greeley, Colorado, for the period 1951-70. Based on these records, the 7-day, 10-year low flow is 6 cfs. The records show that in 18 of 20 years, the 7-day low flow occurred from May to September. Flows at this station are affected by diversion just upstream (RM 4.6). The low-flow data from the gaging station and the flow records of the diversion were examined for the same 7-day periods and were used to determine flow at a point just downstream from the wastewater treatment plant (RM 5.2). The low flow for this station, with this method, was about 30 cfs, of which approximately 11 cfs was Greeley wastewater. In the past 20 years, the flows to the diversion ditch have averaged 29 to 49 cfs during the irrigation season (late April to early October) with no diversions on some days and up to 67 cfs diverted on others.

In addition, low-flow conditions were examined for the period of October 7 to January 31* at the gaging station. The 7-day, 10-year low flow was found to be about 12 cfs. From 20 years of record, it was found that the 7-day, low-flow period occurred 17 times in October. Flows at the gaging station contain the effluent from the Great Western mill at Greeley (about 10 cfs). Thus, the flows at RM 5.2 were estimated by adding the diversion flows, if any, to the gaging station flows and then subtracting the Great Western flows. Under these circumstances the low flow at RM 5.2 (10 percent of the time) was about 30 cfs.

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* The sugar-beet processing season (campaign) generally commences the first part of October and ends sometime in January.

Waste treatment requirements were calculated on both low-flow conditions observed during October to February and on the maintenance of a stream DO concentration of not less than 3.0 mg/1. In order to maintain this concentration it will be necessary that:

1) the Great Western sugar-beet processing mill install treatment in order to obtain an effluent containing not more than 0.5 lb each of BOD and suspended solids per ton of sliced beets (a maximum load of 1,165 lb per day of each based on 1971-72 campaign figures);
2) the effluent from the Greeley wastewater treatment plant contain not more than 25 mg/1 each of BOD and suspended solids (maximum allowable discharge 1700 lb per day at design flow); and
3) the flows in the Cache la Poudre upstream of the Greeley wastewater treatment plant be maintained at not less than 15 cfs.

Additional treatment facilities, as stated previously, will be constructed at a site about five miles east of Greeley. It has been reported that this system will produce an effluent containing a BOD of 20 mg/1 or less and that the effluent will be used for irrigation or discharged to a dry wash which empties into the South Platte River. The new facility is scheduled to be in operation by early 1973. It will reduce the waste loads to the present treatment plant by more than 50 percent. This should allow this plant to meet the effluent limits of 25 mg/1 each of BOD and suspended solids.

REFERENCES

1. Water Pollution Control Commission, Colorado Department of Health, *Water Quality Standards and Stream Classifications*, 1971.

2. U. S. Department of the Interior, Federal Water Pollution Control Administration, *Proceedings, Conference in the Matter of Pollution of the South Platte River Basin in the State of Colorado, Second Session, Denver, Colorado, Reconvened November 10, 1966.*

3. *Criteria Used in the Review of Wastewater Treatment Facilities*, Colorado Department of Health, Denver, Colorado.

4. PR-8, *The Beet Sugar Industry - The Water Pollution Problem and Status of Waste Abatement and Treatment*, U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, Denver, Colorado, June 1967.

5. U. S. Department of the Interior, Federal Water Pollution Control Administration, South Platte River Basin Project, *Water Quality, Middle Basin Tributary Streams, South Platte River Basin, Summer 1965.* PR-7, Denver, Colorado, December 1967.

6. U. S. Department of Health, Education, and Welfare, Federal Water Pollution Control Administration, *Report to the Second Session of the Conference in the Matter of Pollution of the South Platte River Basin,* South Platte River Basin Project, April 27, 1966.

COLORADO WATER QUALITY STANDARDS

Waters of the State, the quality of which exceeds the limits set in these standards, will be maintained at existing quality unless and until it can be demonstrated to the State that a change in quality is justified to provide necessary economic or social development. In that case, the best practicable degree of waste treatment to protect the current classification of such waters will be required. The appropriate Federal authority will be provided with information, from time to time, required to discharge his responsibilities under the Federal Water Pollution Control Act, as amended. (Adopted October 13, 1970.)

I. BASIC STANDARDS APPLICABLE TO ALL WATERS OF THE STATE:

A. All wastes capable of treatment or control prior to discharge into any waters of the State, shall receive secondary treatment with disinfection or its industrial waste equivalent, as determined by the State Water Pollution Control Commission. Lesser degrees of treatment or control may be permitted only where it can be demonstrated that the standards applicable to the classified use of the water can be attained. Greater degrees of treatment or control will be required where it can be demonstrated that it is necessary to comply with the standards applicable to the classified use of the water.

B. Free from substances attributable to municipal, domestic, or industrial wastes, or other controllable sources that will either settle to form unsightly, putrescent, or odorous bottom deposits, or will interfere with the classified use of the water.

C. Free from unsightly floating debris, oil, grease, scum, and other floating material attributable to municipal, domestic, or industrial wastes, or other controllable sources.

D. Free from materials attributable to municipal, domestic or industrial wastes, or other controllable sources that will produce objectionable odor, color, taste, or turbidity in the water, or objectionable aquatic life which may result in eutrophication or other conditions that interfere with the classified use of the water.

E. Free from high temperatures, biocides, toxic, or other deleterious substances attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to human or animal life.

F. Radioactive materials attributable to municipal, industrial, or other controllable sources will be minimum concentrations that are physically and economically feasible to achieve. In no case shall such materials in the stream exceed the limits established in the current edition of the U. S. Public Health Service Drinking Water Standards or the limits approved by the Federal Radiation Council, or, in the absence of any limits specified by the U. S. Public Health Service or the Federal Radiation Council, 1/30 of the 168-hour-week values for other radioactive substances specified in the National Bureau of Standards Handbook 69.

II. SPECIFIC STANDARDS ESTABLISHED BY THE STATE OF COLORADO:

Class B-2 - The following standards shall apply to waters classified for fish and wildlife (Warm Water Fishery):

a. Bacteria: Wastes or substances from controllable sources shall not be discharged into these waters in amounts which will cause the number of organisms of the fecal coliform group, as determined by either multiple tube fermentation or membrane filter techniques, to exceed a log mean of 1000 per 100 milliliters or exceed 2000 per 100 milliliters in more than 10 percent of the samples collected in any 30-day period.

b. Dissolved Oxygen: In warm water fisheries, dissolved oxygen content shall in no case go below 5 milligrams per liter.

c. pH: The pH shall be maintained between 6.5 and 8.5. No controllable pH change will be permitted which will interfere with fish and aquatic life.

d. Turbidity: No turbidity shall exist in concentrations that will impair natural and developed fisheries.

e. Temperature: In warm water fisheries the temperatures shall not exceed 90°F. No controllable temperature change will be permitted which will interfere with spawning and other aspects of fish life.

Limits on temperature change have not been established due to lack of historical temperature data and lack of conclusive temperature change criteria for the aquatic biota of waters of the state.

An abrupt change in temperature must be avoided and the normal pattern of diurnal and seasonal changes must be preserved. The maximum allowable temperature increase due to waste discharges in streams will be 5°F.

f. Toxic Material: Free from biocides, toxic, or other deleterious substances attributable to municipal, domestic, or industrial wastes, or other controllable sources in levels, concentrations, or combinations sufficient to be harmful to aquatic life.

g. Other Material: Free from materials attributable to municipal, domestic, or industrial wastes, or other controllable sources that will produce off-flavor in the flesh of fish.

Class C - The following standards shall apply to waters classified for industrial uses:

a. Dissolved Oxygen: Dissolved oxygen content shall not go below 3 milligrams per liter.

b. pH: The pH shall be maintained between 5.0 and 9.0.

c. Turbidity: No turbidity shall exist in concentrations that will interfere with established levels of treatment.

d. Temperature: The temperature shall not exceed 90°F.

Class D-1 - The following standards shall apply to waters classified for irrigation:

a. Total Dissolved Solids (Salt) Concentration: A time-weighted monthly mean at a monitoring station which exceeds the time-weighted monthly mean for a base period established by the Commission by more than two standard deviations shall be subject to review by the Commission.

b. Sodium Adsorption Ratio: A time-weighted monthly mean at a monitoring station which exceeds the time-weighted monthly mean for a base period established by the Commission by more than two standard deviations shall be subject to review by the Commission.

c. Toxic Material: Free from biocides, toxic, or other deleterious substances attributable to municipal, domestic, industrial wastes, or other controllable sources in concentrations or combinations which are harmful to crop life.

WATER QUALITY OBJECTIVES RECOMMENDED TO THE CONFERENCE
AS A RESULT OF
STUDIES CONDUCTED BY THE SOUTH PLATTE RIVER BASIN PROJECT

1. In the main stem of the South Platte River from just downstream from the discharge from the Great Western Sugar Company mill in Brighton, Colorado, to the Colorado-Nebraska state line, and in the Cache la Poudre River from Windsor, Colorado, to its confluence with the South Platte River:

   a. Dissolved oxygen (DO) content be maintained at not less than 4 mg/l.

   b. The 5-day 20°C BOD level not be allowed to exceed 15 mg/l.

   c. The total and fecal coliform levels not be allowed to exceed 5,000 and 1,000 bacteria per 100 ml, respectively.

2. The sugar beet industry provide treatment of wastes so that the total 5-day BOD load discharged any given day in the total effluents entering basin streams or waterways shall not exceed the given value. Residual wastes may be discharged over an extended period of the year if necessary. The limit set for the Greeley plant was 1,100 pounds of BOD per day.

3. There be no settleable solids contained in the total effluents and that suspended solids loads in these effluents not exceed the numerical levels prescribed above for the 5-day BOD.

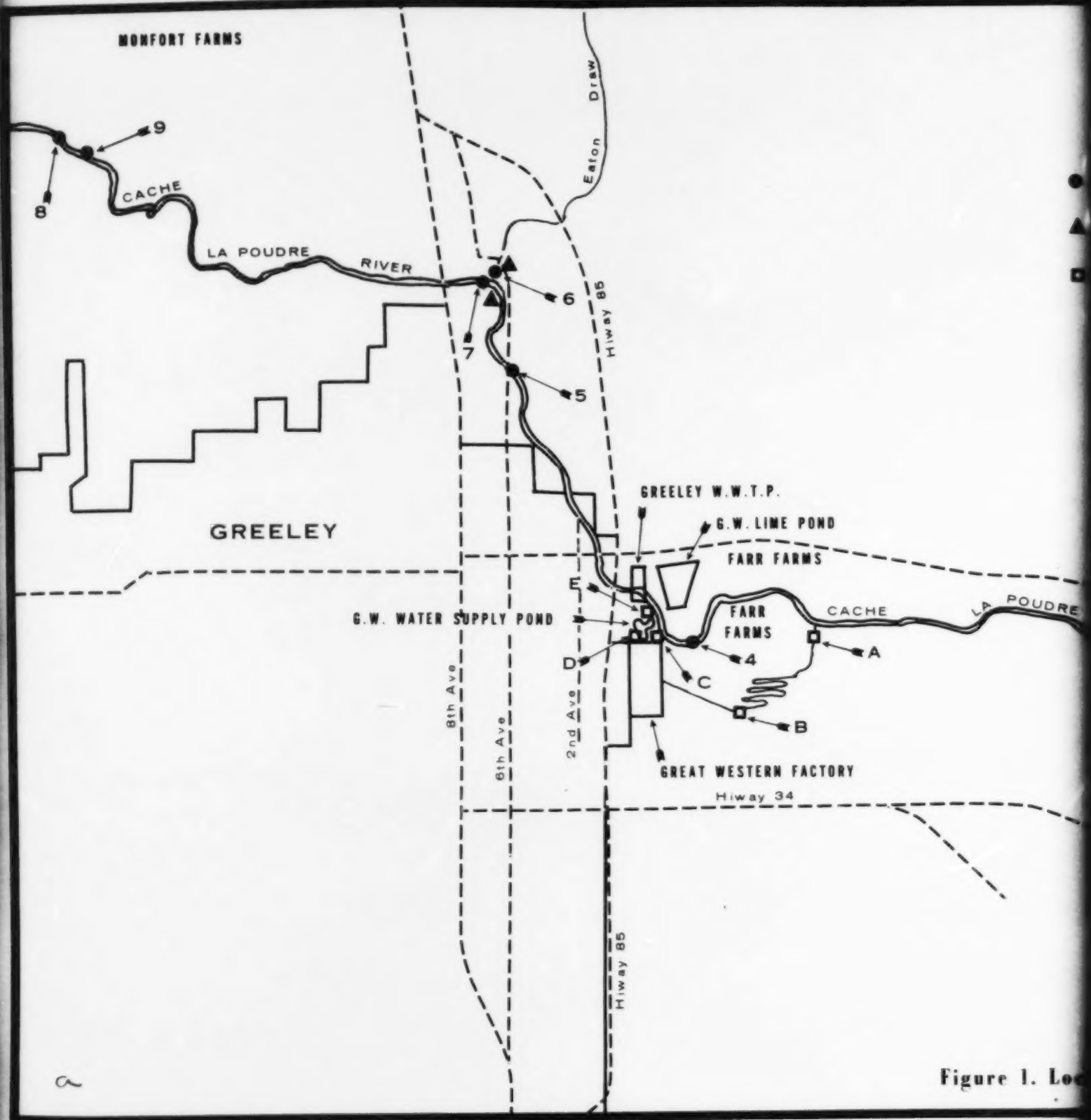
4. Disinfection be provided for each waste discharge so that the receiving stream or waterway directly below each mill shall not show an increase of more than 5,000 total coliform bacteria per 100 ml and 1,000 fecal coliform per 100 ml over the corresponding densities upstream of the mill discharge.

5. Dissolved oxygen in the treated waste effluent shall not be less than 2 mg/l at any time to insure minimum dissolved oxygen concentrations of 4 mg/l in the receiving streams or waterways.

6. There be absence of grease, oil, floating solids, slime or sludge banks in the receiving streams or waterways as the result of waste discharges from the sugar beet mill.

7. There be no disagreeable odors or other nuisances in the areas outside of and immediately adjacent to the plant sites.

8. The waste abatement measures given above for the sugar beet industry in the South Platte River Basin shall be completed by September 30, 1968, to provide full capacity for total plant wastes in the 1968-69 campaign and all subsequent campaigns.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Hiway 85

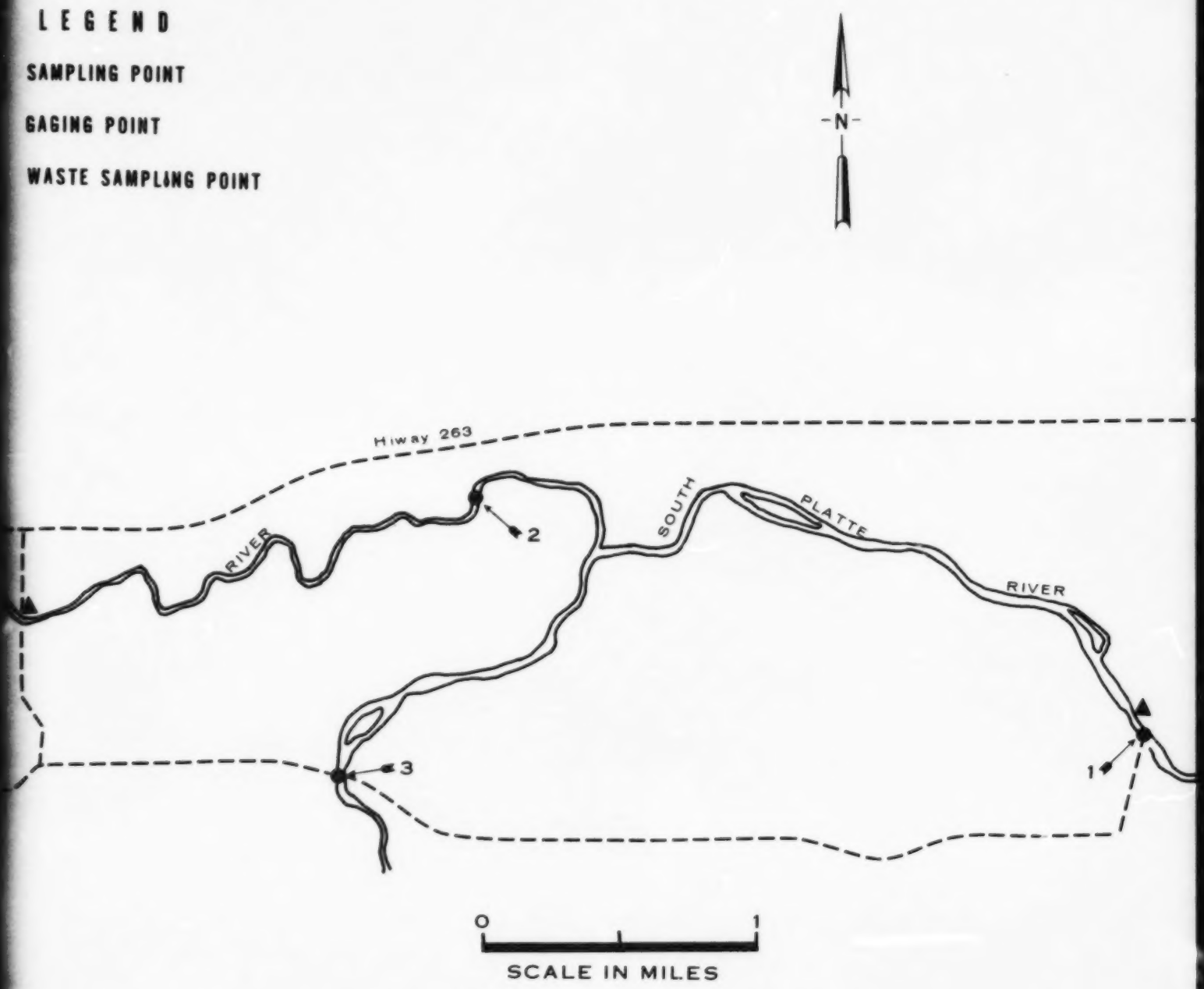
Figure 1. Loc

LEGEND

SAMPLING POINT

GAGING POINT

WASTE SAMPLING POINT



n Map Water Quality Investigations in the Cache La Poudre River Sept - Dec 1971